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IS 11547-3-2 (1985): Electronic Weighing-in-motion Systems, Part 3: Methods of Tests, Section 2: Site Tests [LITD 8: Electronic Measuring Instruments, Systems and Accessories]

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IS : 11547 (Part 3/Sec 2) - 1985

Indian Standard

(Reaffirmed 2000)

SPECIFICATION FOR ELECTRONIC WEIGHING-IN-MOTION SYSTEMS

PART 3 METHODS OF TESTS

Section 2 Site Tests

Electronic Measuring Equipment Sectional Committee, LTDC 21; Panel for Electronic Weighing Instrument and Systems LTDC 21/P4 [Ref : Doc : LTDC 21 (876)]

1. Scope

1.1 This standard (Part 3/Sec 2) describes the site tests carried out to determine the performance of an electronic weighing-in-motion system.

2. Submission Requirements

2.1 *Sample Instrument for Site Tests* — On the successful completion of the laboratory simulated tests, the submittor manufacturer shall arrange for the installation of the weighing instrument on a site with suitable test facilities to enable a static test and dynamic test to be conducted.

More than one instrument with different capacities and site conditions may need to be tested to cover the range of conditions specified in the submission.

The submittor manufacturer shall be responsible for notifying all installations together with their specifications and details of test facilities available.

3. Site Tests

3.1 *General* — As the testing of weighing-in-motion weighing instruments used for weighing large trains presents several difficulties not experienced in testing other weighing instruments, a special test procedure has been devised in order to reduce testing time and costs but still maintain the required accuracy in the calibration of such devices. In general the procedures are as follows.

3.1.1 *Static tests* — Verified test masses equal to the capacity of the instrument shall be placed on the load receptor for the static tests. As the size of the test masses is usually larger than the area of the load receptor, the use of a known mass test trolley with a large platform simplifies the application of the test masses. It also allows the initial calibration to be carried out more quickly and the calibration of each pair of load cells to be checked as the load can be quickly moved on and off the load receptor and to various positions on the load receptor.

3.1.2 *Dynamic tests* — The dynamic errors are found by weighing a typical train on the weighing instrument at the required speeds and comparing the known statically weighed masses of the vehicles with the dynamic mass measured on the instrument. As it is usually difficult, if not impossible, to determine the true mass of each vehicle in a train, a sample number of test wagons of known mass are used to measure the error at various positions in the train. The errors of the unknown wagons between the test wagons are assumed to be proportional to the errors of the test wagons. The errors will vary considerably throughout the train and it is important to sample the errors over the whole train.

The composition of the test train shall be as close as possible to the composition of a typical train to be weighed on that installation. The important features of the test train are:

a) capacity of wagons,
b) number of wagons, and
c) type of wagons (4 wheel, 8 wheel bogie, etc).

The performance of the weighing instrument is also determined by the track layout before and after the load receptor on which the test train will be located during weighing. Therefore, the track layout during testing shall be in the same form in which it will be used when in service.

3.1.2.1 *Total train mass* — As the true total train mass is not known, the individual total train masses obtained during tests cannot be used to determine if the instrument is calibrated correctly. The true total mass of the test wagons is known but as the number of test wagons is much smaller than the total wagons in the train, the individual total masses of the test wagons could vary more than the individual total masses of the whole train. However, it can be assumed that the percentage error of the known mean total dynamic mass of the test wagons is the same as the percentage error of the unknown mean total dynamic mass of the whole train provided sufficient tests are carried out to reduce the uncertainties.

Adopted 24 December 1985

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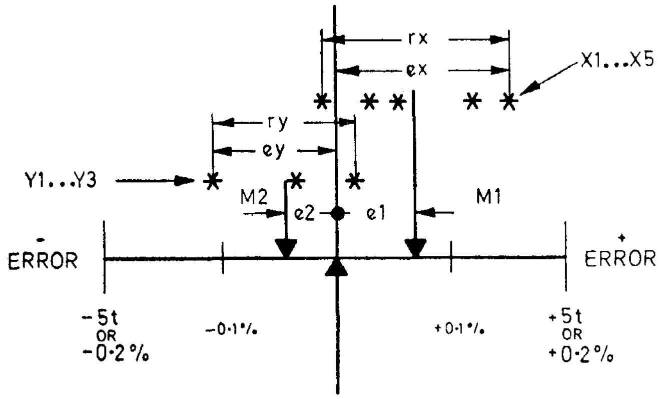
The maximum permissible percentage error for the mean total dynamic mass of the test wagons of all the test runs is taken as half the maximum permissible percentage error for the total dynamic train mass, that is, ± 0·1 percent.

If the *mean* error is within these reduced limits, then the individual total masses of the whole train should lie within the maximum permissible dynamic errors, provided the dynamic repeatability error does not exceed the errors specified in IS : 11547 (Part 2)-1985 'Specification for electronic weighing-in-motion systems : Part 2 Requirements'.

The range of the repeatability error is half the range of the maximum permissible errors and must be determined on the total dynamic mass of the whole train as it is dependent on the number of wagons weighed. As the repeatability error is the difference between the two extreme individual total masses obtained for a given set of conditions, the true mass does not need to be known.

The application of the errors is shown in Fig. 1.



T Total mass measured statically of:

a) sample test wagons (known),
b) train (unknown).

*M*1 and *M*2 Mean total masses measured dynamically at the two extreme speeds of speed range of:

a) sample test wagons (known),
b) train (assumed).

*e*1 and *e*2 Dynamic errors of the mean total masses at the two speeds of:

a) sample test wagons (known),
b) train (assumed).

Maximum permissible errors for *e*1 and *e*2 are ± 0·1 percent.

*X*1...*X*5 and *Y*1...*Y*3 } Total train masses measured dynamically for individual test runs and at the two speeds (known)

rx and *ry* Dynamic repeatability errors of total train masses at each speed. Maximum permissible errors for *rx* and *ry* is 0·2 percent.

rx and *ey* Assumed dynamic train mass errors. If *e*1, *e*2, *rx* and *ry* comply with above maximum permissible errors, it is assumed that *ex* and *ey* are within the maximum permissible errors of ± 0·2 percent.

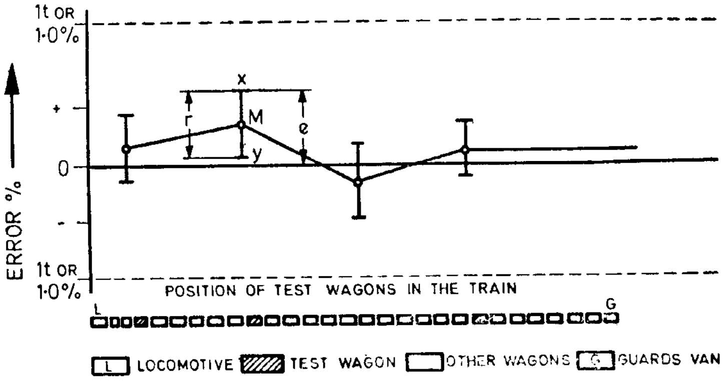
FIG. 1 APPLICATION OF ERRORS

3.1.2.2 *Wagon mass* — Although the true mass of each wagon is not known, the magnitude of the dynamic errors on individual wagons throughout the train can be found from the errors obtained for the test wagons, the true masses of which are known. This is best illustrated in Fig. 2.

3.2 *Test Facilities* — The following test facilities are required to enable static and dynamic testing to be carried out.

3.2.1 *Test masses* — Verified test masses are to be capable of being placed on the weighing instrument and of sufficient quantity to load the instrument to full capacity.

3.2.2 *Test trolley* — A test trolley may be used for the static tests. If it is used as the first test mass its mass shall be verified to ± 0·02 percent. If the weighing instrument is a 'bogie weigher', the trolley shall have two axles spaced at approximately the same spacing as the bogie axles of the wagons.



M	Mean measured dynamic mass of each wagon at one speed.
X and *Y*	Maximum and minimum measured dynamic masses of each wagon at one speed.
e	Maximum dynamic error of each wagon at one speed. Maximum permissible error ± 1·0 percent.
r	Maximum dynamic repeatability error of each wagon at one speed. Maximum permissible error 1·0 percent.

FIG. 2 WAGON MASS

If the weighing instrument is an 'axle weigher', the axle spacing shall be as small as possible to maintain adequate stability. The test trolley shall be fitted with a platform capable of supporting test masses equal to the capacity of the instrument.

3.2.3 *Test wagons* — The test wagons are used for the dynamic tests. At least 5 test wagons are required, having the same number of axles, and approximately the same bogie and axle centres as the wagons to be weighed on the weighbridge. The test wagons shall also be fitted with the same type of coupler and shall be loaded with some stable material (such as steel).

For trains in which the wagons are of equal capacity the mass shall be as close as practicable to the minimum loaded mass of the wagons being weighed provided it is not less than 75 percent.

For trains in which the wagon capacity varies three test wagons shall be heavily loaded as above and the two wagons shall be lightly loaded to no more than 25 percent of the lightest wagons being weighed.

3.2.4 *Verified weighbridge* — The gross mass of each test wagon shall be weighed statically, uncoupled and in a single weighing, on a verified weighbridge to an accuracy of ± 0·05 percent.

3.2.5 *Test train* — The test train used for the dynamic test shall consist of the locomotives and wagons which make up a typical train. The wagons shall be loaded as they would be in a typical train being weighed. If the capacity of the wagons changes, that is, the train is being loaded or unloaded before or after weighing, the wagons shall be in the condition that the majority of them will be behind the test wagon when being weighed. The mass of the wagons does not need to be known.

The number of wagons in the test train shall be as close as practicable to the number in the most commonly weighed typical train. The following examples include cases where there is more than one typical train:

Number of Typical Trains	*Number in Test Train*
10 only	10
10, 20 and 30 only	20
20, 40 and 80 only	40
60, 100 and 150 only	60
Variable from 20 to 80 with 60 the most common	60

The known mass test wagons are inserted in the train after the locomotive at the following positions:

a) after the first two wagons,

b) after 25 percent of the wagons,

c) after 50 percent of the wagons,

d) after 75 percent of the wagons, and

e) at the end of the train.

If the wagon mass is variable the heavy and light test wagons shall be placed as follows:

a) heavy,

b) light,

c) heavy,

d) light, and

e) heavy.

The other wagons in the test train shall also be arranged to ensure a thorough mixing of heavy and light wagons.

To correctly sample the errors in the train, the test wagons shall be separated from any locomotive or dissimilar vehicle by at least two wagons.

If a weighbridge is to be used for weighing gross as well as tare masses, it shall be tested with test trains equivalent to both conditions.

3.3 *Test Procedure*

3.3.1 *Static tests*

3.3.1.1 *General* — The errors applicable to static tests are contained in IS : 9281 (Part 3)-1981 'Specification for electronic weighing systems : Part 3 Requirements'. The particular requirements for the end test are contained in IS : 11547 (Part 2)-1985.

3.3.1.2 *Zero test* — Check that with no mass on the weighbridge the indicator indicates zero within the maximum permissible errors. If the instrument is fitted with an automatic zero correction device, the zero test is carried out with a load equivalent to, say, 10 scale intervals on the load receptor.

3.3.1.3 *Load test and end test*

a) With the test trolley located in the centre of the load receptor, place test masses evenly on the trolley noting the indication for each test load.

b) For a bogie weigher, the end test is carried out when the test load reaches bogie capacity. With the test trolley evenly loaded move it to each end of the load receptor and record the indication. With the test trolley relocated in the centre of the load receptor, continue loading to the capacity of the instrument, recording the results for each additional load. Remove the test masses noting the indications progressively with decreasing load. Check the zero error.

c) For an axle weigher, load the test trolley up to the instrument capacity with the trolley located in the centre of the load receptor. Then, with the trolley located at each end of the receptor, relocate the test masses so that the load over the outside axle at each end is approximately the axle load. The remainder of the test mass is located in-board to provide a counter-balance force for stability of the trolley. Note the indications. Relocate the trolley to the centre of the load receptor and with the test masses evenly distributed on the trolley. Remove the test masses, noting the indications progressively with decreasing load. Check the zero error.

d) At least 5 readings should be taken with increasing load and 5 with decreasing load. All indications shall be within maximum permissible errors specified in IS : 9281 (Part 3)-1981.

e) A schematic diagram showing the various methods of applying the test loads is shown in Fig. 3.

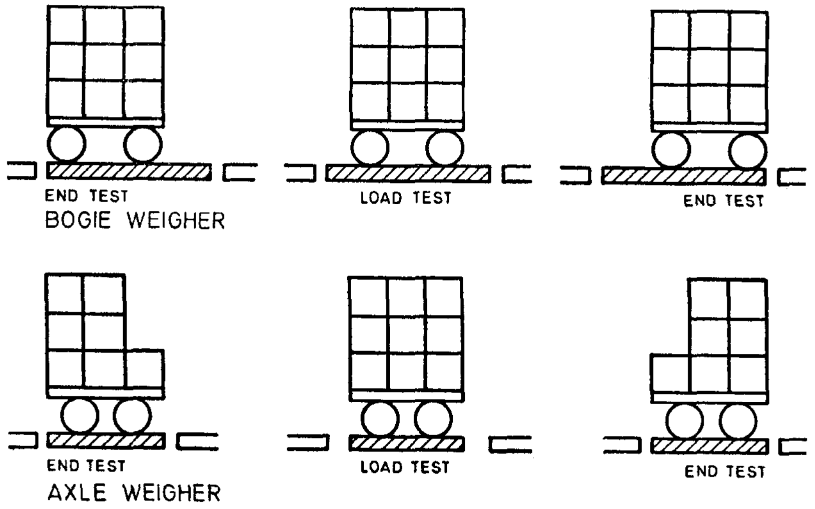


FIG. 3 APPLICATION OF TEST LOADS

3.3.1.4 *Calibration* — If the weighing instrument has not been previously calibrated, adjustments could be made when the end test is being carried out. The trolley with test masses is moved on and off the load receptor and positioned at each end as well as the centre to check the indications at zero and with a load, and to make any adjustments necessary. Once adjustment is made, the indications with decreasing load can be checked directly for compliance with the maximum permissible errors. The indications for the increasing load test obtained before calibration would have to be corrected proportionally to the adjustment made during the test to determine compliance with the maximum permissible errors.

3.3.2 *Dynamic tests*

3.3.2.1 *General* — Using the method described in **3.1.2**, the test train (with test wagons assembled as described in **3.2**), is run over the weighing instrument at various speeds to determine the appropriate errors depending on whether the total train mass or individual wagon masses are required. Test report sheets are given in Appendices A and B.

3.3.2.2 *Total train mass*

a) Carry out at least 5 test runs of the complete train over the weighing instrument at the normal operating speed recording the mass of each test wagon and of all the unknown wagons.

b) Calculate the percentage error of the mean total mass of all the test wagons from their true mass for the 5 test runs. The error shall be within half the maximum permissible dynamic percentage error for the total train mass.

c) From the 5 total masses of the whole train calculate the absolute and percentage errors of the maximum variation between the total masses. The error shall be within the dynamic repeatability error for the total train mass.

d) Repeat (a) to (c) at a speed at the other end of the speed range from the normal operating speed for at least 3 test runs. The results shall also be within the same maximum permissible errors.

e) Repeat (a) to (d) for other directions of travel and for other entry or exit tracks to or from the weighing instrument, if these are applicable.

3.3.2.3 *Wagon mass*

a) Carry out at least 5 test runs of the complete train over the weighing instrument at the normal operating speed, recording the mass of each test wagon.

b) Calculate the absolute and percentage errors for each test wagon for each test run from the known true mass. All errors shall be within the maximum permissible errors for individual wagons.

c) Calculate the absolute and percentage errors of the maximum variation between the 5 test results for each wagon. The errors shall be within the dynamic repeatability error for the wagon mass.

d) Repeat (a) to (c) at a speed of the other end of the speed range from the normal operating speed for at least 3 test runs. The results shall also be within the same maximum permissible errors.

e) Repeat (a) to (d) for other directions of travel and for other entry or exit tracks to or from the weighing instrument, if these are applicable.

3.3.2.4 *Other tests*

a) *Overspeed test* — Run the train over the weighing instrument at a speed just above the maximum speed (approximately 10 percent) to check that the overspeed protective system operates correctly.

b) *Roll-back safeguard* — Run, say 75 percent of the train over the weighing instrument, then stop the train; reverse, say, 25 percent of the train, then complete the weighing of the total train in the forward direction. Check that no wagon is weighed more than once.

c) *Unweighed vehicles* — During the tests described in **3.3.2.2** and **3.3.2.3**, check that the mass is not recorded for vehicles not intended to be weighed, for example, locomotives.

d) If facilities are provided for calculating net mass from gross and tare masses, check during the tests that the calculations are correct.

3.3.2.5 *Calibration and re-testing* — If the instrument has not been previously calibrated, initial adjustments can be made using a short test train consisting of the locomotive, two unknown-mass test wagons and the five known-mass test wagons. However, for initial verification of a site, the complete typical test train shall be used. The short test train will shorten the time taken for initial calibration but although the errors are similar, they will not necessarily be the same as for the total train.

During the initial verification tests a comparison of the errors can be made between the short test train and the total train. The results of this comparison can be used in future reverification using the short test train only.

If the weighing instrument or track work has been altered in any way, after the initial verification the total test train shall be used to reverify the instrument.

APPENDIX A

(*Clause* 3.3.2.1)

DYNAMIC TEST REPORT — TOTAL TRAIN MASS WEIGHING-IN-MOTION WEIGHING INSTRUMENT

Weighing-in-Motion Instrument	**Test Wagons**			**General**
No.	*No.*	*Wagon No. and Type*	*Mass*	
Maximum	1			Owner :
Minimum	2			Location :
e =	3			Material Weighed :
T =	4			Temperature :
Maximum axle or bogie load :	5			Date :
Train speed range :				
No. of wagons in train :		Total Mass		
Wagon type and No. of axles :				

Description	Run 1	Run 2	Run 3	Run 4	Run 5
1. Speed					
2. Mass 1st wagon					
3. Mass 2nd wagon					
4. Mass 3rd wagon					
5. Mass 4th wagon					
6. Mass 5th wagon					
7. Total mass of 5 wagons					
8. True total mass of 5 wagons					
9. % Error total mass $\left(\frac{7-8}{8} \times 100\right)$					
10. Total train mass					

Average % error of total test wagon mass $\frac{(\Sigma 9)}{\text{No. of Runs}}$ =..........................% at.......................... km/h (MPE ± 0·1 %)

Maximum repeatability error (*Max* 10 − *Min* 10) or $\left[\frac{Max\ 10 - Min\ 10 \times 100}{\text{Av } 10}\right]\%$ =..............t or......% at ....km/h (MPE 5t or 0·2%)

Signed............................Date.............................

Checked..........................Date.............................

APPENDIX B

(*Clause* 3.3.2.1)

DYNAMIC TEST REPORT — WAGON MASS WEIGHING-IN-MOTION WEIGHING INSTRUMENT

Weighing-in-Motion Instrument	**Test Wagons**			**General**
No.	*No.*	*Wagon No. and Type*	*Mass*	
Maximum =	1			Owner :
Minimum =	2			Location :
e =	3			Material weighed :
T =	4			Temperature :
Maximum axle or bogie load :	5			Date :
Train speed range :				
No. of wagons in train :		Total Mass		
Wagon type and No. of axles :				

	Description	Run 1	Run 2	Run 3	Run 4	Run 5
1	Speed					
2	1st Wagon — Mass					
3	— True mass					
4	— Error (2—3) or $\left[\frac{2-3}{3} \times 100\right]\%$					
5	2nd Wagon — Mass					
6	— True mass					
7	— Error (5—6) or $\left[\frac{5-6}{6} \times 100\right]\%$					
8	3rd Wagon — Mass					
9	— True Mass					
10	— Error (8—9) or $\left[\frac{8-9}{9} \times 100\right]\%$					
11	4th wagon — Mass					
12	— True mass					
13	— Error (11—12) or $\left[\frac{11-12}{12} \times 100\right]\%$					
14	5th wagon — Mass					
15	— True mass					
16	— Error (14—15) or $\left[\frac{14-15}{15} \times 100\right]\%$					

Maximum wagon errors + ...t or...................... %and — ....t or.................. % at........................km/h (MPE ± 1 t or ± 1·0%)

Repeatability error (Worst wagon, *Max* error—*Min* error) =........................t or........................ % for wagon No. ....at ....km/h (MPE 1 t or 1·0%)

Signed..............................Date..............................

Checked..............................Date..............................

EXPLANATORY NOTE

The examination of a pattern of a weighing-in-motion weighing instrument by a certifying authority consists of the following three separate tests:

a) Simulation tests carried out in the pattern approval laboratory to determine the performance of the various components of the instrument. The tests are carried out using static test loads.

b) Static tests carried out on an instrument installed on site using verified test masses.

c) Dynamic tests carried out on the same instrument using a sample test train with test vehicles of known mass.

While preparing this standard, assistance has been derived from Manual No. 8 'Design manual for weighing-in-motion systems for trade use', issued by the National Standards Commission, Australia.

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